GEO-XO User Engagement Workshop

Fire Workshop Initial Findings

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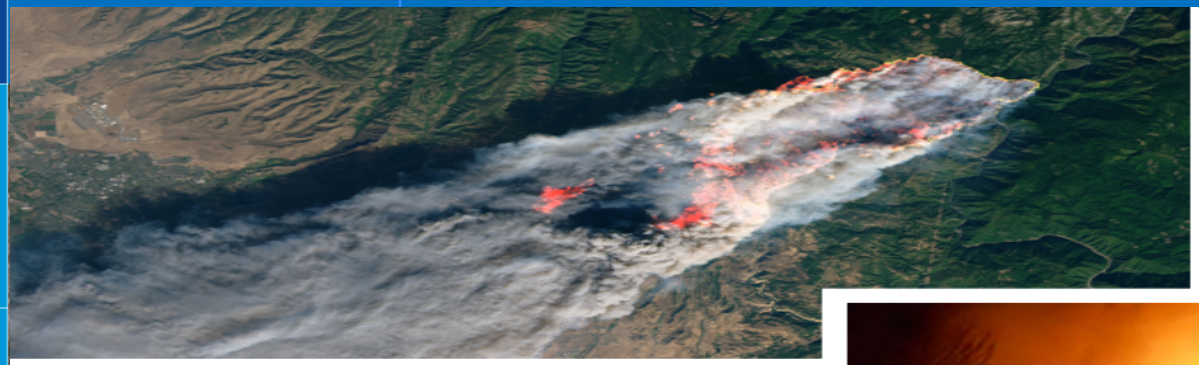
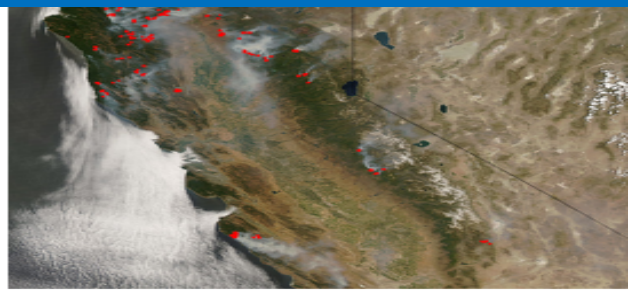
GEO-XO User Engagement Team and the GEO-XO Program
June 3-5, 2020

GEO-XO User Engagement

The National Oceanic and Atmospheric Administration (NOAA) is soliciting stakeholder feedback in a number of ways, including surveys, stakeholder interviews, and workshops.

NOAA and GEO-XO are conducting a series of stakeholder engagement workshops to inform the development of our geostationary and extended orbit satellite program, known as GEO-XO, slated for operations 2030-2050.

This fire workshop is one of several opportunities to provide input to NOAA on the ways in which new or improved environmental data could help you, our stakeholders, address pressing societal and environmental challenges and build a prosperous and sustainable future. Input from stakeholders at the federal, state, local, territorial, and tribal levels, as well as from the private sector and academia is welcomed.

For any questions regarding GEO-XO or NOAA's user engagement please contact Vanessa Escobar at vanessa.escobar@noaa.gov

Thanks to our community of users for their time and commitment to making observations better for the future.

~The GEO-XO Program

GEO-XO Introduction

- ***GEO-XO = Geostationary and Extended Orbits***
  - Initiative in NESDIS GEO Portfolio that will develop the missions that follow GOES-R and SWFO for operation in 2030-2050 timeframe
- GEO-XO will study and develop plans to implement:
  - All NOAA assets deployed at altitudes above LEO
    - Ie, GEO, Sun-Earth L1, Sun-Earth L5 (if any), Highly Elliptical Orbits (if any)
    - Includes instruments & comm relays hosted on commercial or partner SC (if any)
  - Ground system to support the above NOAA assets and to ingest and distribute partner data that supports NOAA mission
  - Final definition of scope and structure to be defined in formulation phase
    - Anticipate creating separate programs for GEO/HEO Earth Observing, Space Weather, and Enterprise Ground
- Observations currently in consideration based on NSOSA results, NESDIS leadership direction, and user input

Earth		Solar	Space Weather
Imager	Hyperspectral Sounder	UV Imager	Particle Sensor
Day/Night Imager		Irradiance Monitor	Magnetometer
Lightning Mapper	Atmospheric Composition	Coronagraph	Auroral Imager
Ocean Color		Photo. Magneto. Imager	Solar Wind

The Next Decade of GEO

ALL DATES SUBJECT TO APPROVAL BY FUNDING AUTHORITIES; PARTNER DATES ARE FROM INTERNET SOURCES

Fire Workshop Logistics and Framing Details

Agenda and Total Participation

Wednesday, June 3, 2020		
11:30 AM – 12:30 PM EDT	**Plenary: Opening Session** ▪ Workshop introductions ▪ Workshop overview ▪ Brief overview of GEO-XO Program ▪ Overview of high-level scenario in the sessions	**104 Attendees**
12:30 – 2:00 PM EDT	**Session 1: Fire Preparedness** ▪ Fire Danger and Risk Management ▪ Fire Planning	**109 Attendees**
3:00 – 5:00 PM EDT	**Session 2: Fire Response** ▪ Ignition Detection ▪ Fire Progression ▪ Fire Behavior and Spread	**105 Attendees**
Thursday, June 4, 2020		
12:00 – 2:00 PM EDT	**Session 3: Damage Assessment** ▪ Post-Fire Assessment/Mapping ▪ Fire Emissions Modeling ▪ Smoke Management	**107 Attendees**
3:00 – 5:00 PM EDT	**Session 4: Critical Infrastructure** ▪ Fire Weather Impacts to the Grid ▪ Transportation Infrastructure (including Smoke Hazards in Aviation) ▪ Wildland Urban Interface Factors ▪ Other Infrastructure Impacts	**71 Attendees**
Friday, June 5, 2020		
1:00 – 2:30 PM EDT	**Plenary: Closing Session** ▪ Brief hotwash ▪ Closing remarks by key NOAA personnel ▪ Highlight next steps, including follow-up surveys and interviews	**67 Attendees**

Organizations in Attendance

The GEO-XO program is proud to engage over 200 stakeholders across a wide range of sectors in this workshop.

95+

Individuals representing U.S. Federal Agencies

25+

Individuals representing State, Local, Tribal, and Territorial Organizations

30+

Individuals representing Academic Institutions

15+

Individuals representing the Private Sector

35+

Individuals representing International Governments and Institutions

Attending Organizations

Type	Attending Organizations (full list available upon request)	
Academia	▪ Boise State University ▪ Colorado State University ▪ Michigan Tech Research Institute ▪ Pacific Cooperative Studies Unit ▪ University Corporation for Atmospheric Research ▪ Universidad Nacional Autonoma de Mexico	▪ University of Alaska, Fairbanks ▪ University of Colorado, Denver ▪ University of Hawaii, Manoa ▪ University of Maryland ▪ University of Wisconsin
Private Sector	▪ Becker Support Services, LLC ▪ CASE Consultants International	▪ International Association of Fire Chiefs ▪ StormCenter Communications, Inc
Intl. Govs. and Institutions	▪ CAF Development Bank ▪ Government of Canada – Canadian Forest Service – Canadian Space Agency – Environment and Climate Change Canada – Natural Resources Canada ▪ Government of Ecuador – Military Geographic Institute	▪ Government of Jamaica – Forestry Department – National Spatial Data Management Division ▪ Government of Mexico – Ministry of the Environment and Natural Resources – National Commission for the Knowledge and Use of Biodiversity

GEO-XO Fire Session Objectives

1. Identify the operational constraints and drivers affecting how stakeholders achieve their missions.

2. Identify capability gaps and user needs in fire danger and risk management, and fire planning.

3. Explore how remote sensing data and capabilities can enhance various types of decision-making for external stakeholders during day-to-day operations, disaster incident response, and long-term studies and initiatives.

4. Expand and enhance relationships between NOAA and external end-users of NOAA remote sensing products.

Workshop Terminology

The purpose of this Workshop is to explore *capability gaps* and identify potential *user needs* associated with particular *use-cases* across the fire stakeholder community. These are defined as follows:

- A use-case is used to define a category of remote sensing applications that are relevant to a particular topic or mission area.
- Capability gaps refer to the lack of certain abilities or decision-support, needed to fulfill a mission, that can be traced to a particular technical constraint or information limitation
- User needs describe specific *types* of information or data that provide end-users with a particular capability.

Problem Space			Solution Space	
Workshop Focus			Surveys & Interviews	GEO-XO Program
Use-Case	Capability Gap	User Need	Performance Parameters	Functional / Design / Material Specification
Ignition Detection	*End-users lack real-time wide-area capabilities to detect new fires*	*Geo-located satellite imagery with capability to detect fire ignition on a variety of bands*	*Spatial resolution (1m); temporal resolution (3 min)*	*Infrared sensor band requirements*

Fire Workshop Scenario and Use Case Details

Assumptions and Artificialities

Assumptions and artificialities are necessary to establish a universally accepted basis upon which the scenario can be built. The following information should be assumed throughout the scenario and discussion:

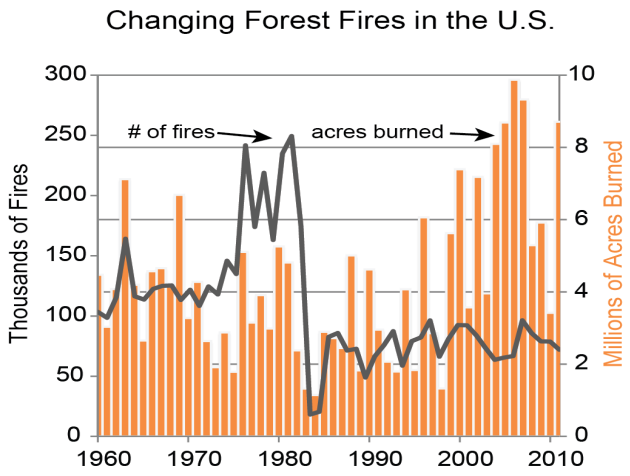
- The GEOXO user engagement team will simulate a 2030-2050 scenario during the Workshop, which will operate on several assumptions to be taken at face value.
- It is to be assumed that no great leaps in technology have happened that fundamentally change the current operating structure and response mechanisms to wildfire.
- Participants will use existing plans, policies, and procedures to frame their responses, and will react to the information and situations they are presented with from the perspective of their actual role and position.
- There is no 'hidden agenda,' nor any trick questions.

Session Structure

- Workshop participants will be presented with a hypothetical fire scenario within the 2030-2050 timeframe. This scenario will be used to guide the discussion.
- Discussion will be structured to identify capability gaps within the relevant use-case. These capability gaps reflect user needs that will be considered in the design of the GEO-XO Program.
- Importantly, the scenario is not designed to be solved; that is, the goal of this discussion is not to put the fire out. Instead, the intention is to understand capability gaps and user needs critical to effective and timely decision making.
- The discussion sessions will not focus on current NOAA products

Scenario Summary 2030-2050

- Atmospheric CO_2 concentration has recently surpassed 500 ppm.
- The West and Southwest have seen a significant increase in area burned by wildfires due to larger, more intense blazes that are harder to contain under drier, warmer conditions.
- Extreme fire years have dramatically worsened, with 95% more area burned during extreme fire years than was burned during extreme fire years between 2001-2010.
- Changes in wildfire patterns have been heterogeneous across the country; on the whole, wildfires and the associated smoke hazards have increased in both severity and frequency from the 2020 baseline.

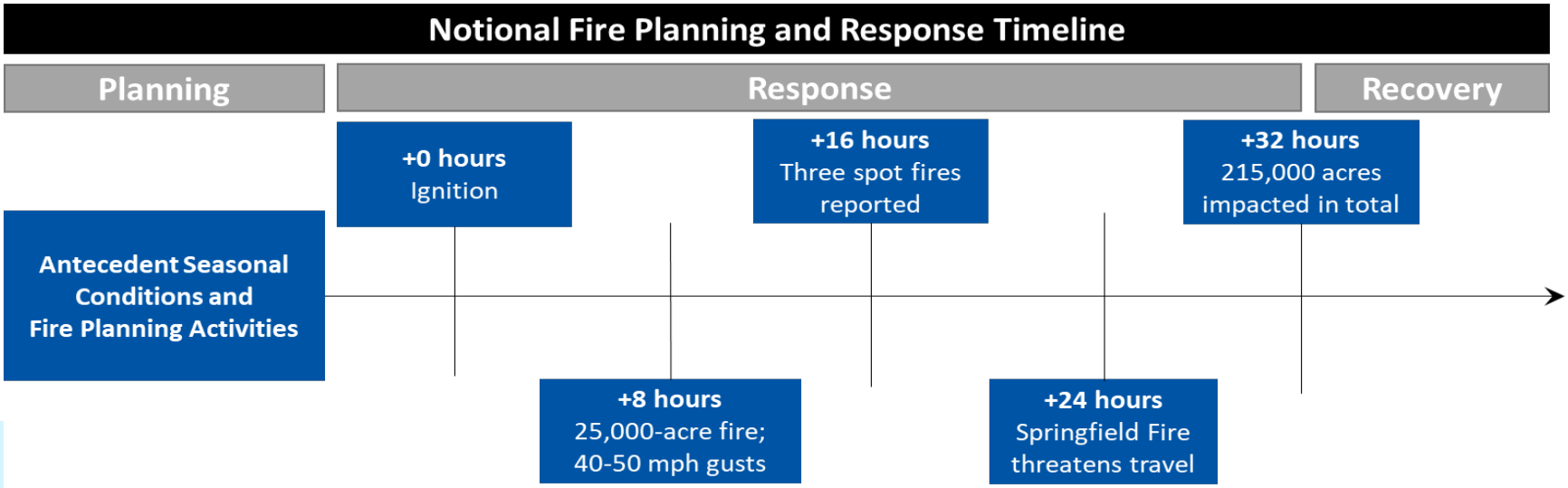


Number of Fires and Acres Burned by Year, 1960-2010.

Springfield Fire Summary

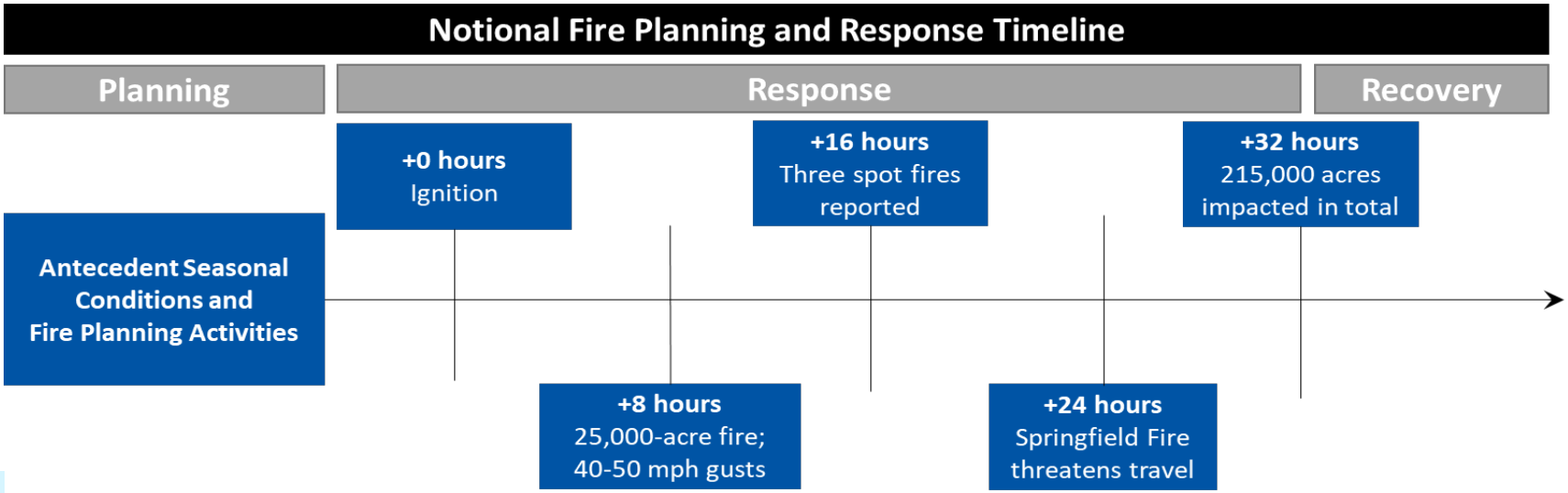
It is early September 2040. After a warmer and drier August than the 2030 – 2040 average, a 10-day heat wave with temperatures projected to stay above 94°F and a 10% relative humidity is projected between September 2nd and 12th. On September 4th, the National Weather Service issues a red flag warning.

- **+0 hours from ignition:** Twelve hours after the National Weather Service issues a red flag warning, flames are reported at a single location near a camp site.
- **+8 hours:** The flames have consolidated into a 25,000-acre fire that has begun to spread to the northwest.



Springfield Fire Summary

- **+16 hours:** At least three additional spot fires have been reported, each reaching 15,000-18,000 acres. All three spot fires are minimally contained.
- **+24 hours:** The primary fire, now being referred to as the Springfield Fire, threatens three interstate highways. Non-threatened roads are experiencing major traffic delays. 50% of the region lacks cell reception. Three health care centers have lost power and are at risk of becoming inaccessible.
- **+32 hours:** The Springfield Fire reaches 125,000 acres and remains only 10% contained. The three spot fires grow to 25,000-35,000 acres each and 5-8% contained. Three towns are immediately threatened by the flames.



Overview: Use-Cases

A use-case is used to define a category of remote sensing applications that are relevant to a particular topic or mission area.

11 use-cases were discussed across 4 discussion sessions with 100+ stakeholders.

- Fire Preparedness
  - Fire Danger and Risk Management
  - Fire Planning
- Fire Response
  - Ignition Detection
  - Fire Progression
  - Fire Behavior and Spread
- Damage Assessment
  - Post-fire Assessment and Mapping
  - Fire Emissions Modeling
  - Smoke Management
- Critical Infrastructure
  - Fire Weather Impacts to the Grid
  - Impacts on Transportation
  - Wildland Urban Interface Factors

Use-Case Definitions

Use-Case	Definition
Session 1: Fire Preparedness	
1: Fire Danger and Risk Management	Short term and long term forecasting and modeling of the risk for the occurrence of significant wildland fire activity, rapid fire growth, etc.
2: Fire Planning	The plans, policies, and procedures which inform strategies to mitigate the occurrence catastrophic wildland fire incidents and increase the efficacy of preparation, coordinated response and risk reduction efforts.
Session 2: Fire Response	
3: Ignition Detection	Accurate and reliable identification of new wildland fire ignitions based on detection of flames/heat, smoke, and other indications of fire activity.
4: Fire Progression	The process of tracking the location and spread of active burning on an incident from ignition through containment/suppression.
5: Fire Behavior and Spread	Forecasting/modeling a fire's response to conditions and its anticipated rate and extent of spread in order to inform decisions on the deployment of suppression resources.

Use-Case Definitions

Use-Case	Definition
Session 3: Damage Assessment	
6: Post-Fire Assessment/Mapping	The mapping of the location, extent or degree of damage as a result of a fire, including damaged/destroyed structures and infrastructure, vegetation and soil burn severity, risk and mitigation of potential hazards, etc.
7: Fire Emissions Modeling	The estimation of emissions released by wildland fires and their environmental impact based on models using several input parameters (fuel types, biomass quantity, rate of consumption, fire energy release, etc.).
8: Smoke Management	Assessment of data and information on planned and unplanned fire emissions, smoke and air quality conditions and their impacts on public safety and health as well as visibility in protected areas.
Session 4: Critical Infrastructure	
9: Fire Weather Impacts to the Grid	Prediction and determination of the impacts to the electric grid availability and operations caused by forecasted fire danger, fire weather conditions or wildland fire activity.
10: Impacts on Transportation Infrastructure	Prediction and determination of impacts on transportation infrastructure caused by forecasted fire danger, fire weather conditions or wildland fire activity, including impacts to aviation, rail operations, etc.
11: Wildland Urban Interface Factors	Special considerations and needs for data, information and applications to improve the ability to mitigate and respond to the threat of fire to the wildland urban interface and the improved protection of human life and property in those areas.
12: Other Infrastructure Impacts	Assessment of the impacts of forecasted fire danger, fire weather conditions or wildland fire activity on infrastructure other than transportation and electricity.

High Level Findings

Capability Gaps

Capability gaps refer to the lack of certain abilities or decision-support, needed to fulfill a mission, that can be traced to a particular technical constraint or information limitation.

- Access to and compatibility with archival data to compare current conditions to prior fire years
- Enhanced ability to detect active fire perimeter, particularly beneath smoke cover
- Improvements in data format and compatibility with existing systems and other data sources
- Ability to detect smoldering/low intensity fires
- Finer spatial resolution to track fire progression and spread
- Improved post-fire visibility in cloudy areas
- Higher temporal resolution for post-fire damage assessments
- Smoke detection at night; ability to 'see through smoke' during day
- Access to more detailed data about fuel conditions/moisture

User Needs

User needs describe specific *types* of information or data that provide end-users with a particular capability.

- 30m resolution of fuel characteristics for modeling
- Single gain and dual gain channels for 3.9 micron (like VIIRS) for fire tracking, as well as higher spatial resolution
- Addition of a day/night band (like VIIRS) for fire and especially smoke tracking at night
- Near continuous data (maximum interval of 5 minutes) for fire perimeter tracking; highest possible spatial resolution
- For burn scar mapping, 250m res in <7 days for boreal landscape; 30m res in 2-4 days in the lower forty-eight states
- 10-30m resolution to see smoke plume movement near highways

Tools and Systems

A tool or system is an existing technological capability which *utilizes remotely sensed data* that you leverage to support your work in wildfire management.

- FireCast
- Fire Enterprise Geospatial Portal (EGP)
- GOES 16 and GOES 17 Products
- Light Detection and Ranging (LiDAR) before/after fires
- Moderate Resolution Imaging Spectroradiometer (MODIS) Products
- National Fire Incident Reporting System (NFIRS)
- National Infrared Operations (NIROPS) Products
- Technosylva
- Visible Infrared Imaging Radiometer Suite (VIIRS) Fire
  - Day-Night Band
  - Soil Moisture
  - Vegetative Index
- Wildland Fire Decision Support System (WFDSS)

Key Takeaways

1. The community needs help with fuels data (i.e., how wet or dry is the ground and vegetation)
2. They would like to have our data provided in a GIS-friendly format (Note: NOAA will start looking at GIS friendly format for GOES-R Products as well)
3. First detection from satellites is very rare – it's usually from the public. Satellites mainly used to monitor fire spread with time
4. They suggest a combined GEO/LEO product with active fires
5. Request for a dual-gain ~3.9 micron band (allows for higher saturation temperature)
6. The most coarse resolution data that would be helpful for post-fire burn scar mapping is around 250 m, and they'd probably need more than just 1 VIS band (very unlikely from GEO or Tundra)
7. Smoke detection/tracking at night is difficult to impossible with current satellite technology. A GEO DNB could help with this.
8. They need 1 km resolution 3.9 band
9. Co-development of a hi-resolution vegetation classification map combined with fuel maps for fire planning.

Findings Broken Down by Use Case

Use-Case 1: Fire Danger and Risk Management

- Information is needed more frequently during planning season to inform where supplies are staged
- Accurate data on fuels (particularly fuel moisture content) is a high priority need
- Better data on the dispersion and transport of smoke and mixing height is another capability gap
- Ability to track lightning strikes and other natural ignition causes would be useful to inform both short-term forecasting (up to 1 week) and initial incident response

Tool(s) Identified: Technosylva

Use-Case 2: Fire Planning

- Archival data is critical to fire planning efforts, so current conditions can be compared longitudinally
- Increasing the accuracy of long-range forecasting, through improving the quantity and type of variables gathered, would improve planning capabilities
- Land cover change is also critical to maintain updated awareness of (e.g., new construction) when identifying high risk areas
- Fuel moisture content was again identified as a high priority variable which is currently a limiting factor for both emergency response and academic modeling
- Data needs to be available in GIS-compatible formats, so users can easily integrate it into their existing systems

Tool(s) Identified: LANDSAT, National Fire Reporting System (NFRS)

Use-Case 3: Ignition Detection

- Tracking low-intensity fires is a particular challenge
  - It is rare that responding organizations (e.g., CALFIRE) are notified by remote sensing *first*, typically they are notified by callers
  - GOES can quickly and accurately identify fires; this information is just not disseminated in time to responding to organizations
  - Most commonly, remotely sensed ignition is useful for largely rural contexts (e.g., Alaska)
- Users struggle to be able to understand *when* fires are increasing in intensity because data is not available frequently enough, particularly with low-intensity and tundra fires
- Spatial resolution is typically too coarse to detect very small fires (2-4 acres) which requires ignition detection to be supplemented by other tools

Tool(s) Identified: Fire EGP, GOES 16 and 17, MODIS, VIIRS, Fire Color RGB, Fog Detection

Use-Case 4: Fire Progression

- Users cannot see through smoke, which means they do not have an accurate picture of what the boundaries of the fire are – this is the highest priority need
- Currently users are limited by both their ability to digest data and get remotely sensed products in the right place at the right time
- Existing systems (GOES R and S) have good spectral and temporal resolution, but the spatial resolution is too coarse to inform response
- Fuel moisture/dryness is critical to inform how the fire may spread
- Smoldering fires are also a particular challenge, since they will intermittently burn and it is hard to determine if a fire has been contained or not

Tool(s) Identified: MODIS, VIIRS, GOES R and S, Aircraft Flyover

Use-Case 5: Fire Behavior and Spread

- Response organizations do not know where the "frontier" of the fire is – remotely sensed data is available 1-2 times per day, and the rest of the time organizations are reliant on firefighters with radios for risk intelligence
- Fire growth modeling focuses on understanding the characteristics of fires to help predict behavior; this will be informed by higher spatial and temporal resolution
- There is a high priority need to reduce the "Valley of Death", the delay between the product being acquired by agencies and that product being shared/utilized by response organizations
- Data format needs to be GIS-compatible, to reduce the amount of time it takes to be ingested into programs for analysis and resource deployment

Tool(s) Identified: GOES-R

Use-Case 6: Post-Fire Assessment and Mapping

- A primary customer of this data are Burned Area Response (BAER) Teams, who need data within a week to make assessments; higher temporal resolution will aid this effort
- When considering weather forecasting (e.g., flash flood warnings), data is needed more frequently; as soon as watersheds have been affected warnings need to be issued
- Higher resolution imagery is required to help identify built-up areas (e.g., individual homes, particularly in a rural context)
- Pre- and post-incident LiDAR would help with comparative damage analysis
- Continuity of data is critical for archival, forecasting, and funding purposes

Tool(s) Identified: LiDAR, LANDSAT, NIROPS, Sentinel, USFA Policy

Use-Case 7: Fire Emissions Modeling

- The Blue Sky Framework is limited because it assumes nothing will change when predicting behavior; need a more adaptive algorithm
- Emissions modeling can help inform changes in fire intensity, particularly in Boreal forests
- Emissions models need the ability to recognize differences in soil depth to ensure accuracy of smoke modeling projections
- More continuous data (LiDAR) would help us monitor fuel beds
- Fuel moisture content can have a major impact – this is currently not well tracked
- Fire perimeters are not updated frequently enough, which means emissions modeling always has a ~12 hour lag

Tool(s) Identified: Blue Sky Modeling Framework, LiDAR, FRP, GOES

Use-Case 8: Smoke Management

- Currently smoke management is primarily visual (where the column currently is, what communities are beneath it); remotely sensed data does not have a high enough temporal frequency
- A huge limitation is the inability to see through smoke to what is beneath
- Super fog (a combination of smoke and dense fog) can have huge transportation impacts; remote sensing can identify both components, but struggles to identify this phenomenon when it occurs
- Tracking smoke at night is currently nearly impossible; infrared can help, but this is currently a major limitation
- Capability to know the chemical compositions of smoke plumes is also critical for first responder and community safety

Tool(s) Identified: Air Resource Advisors, VIIRS, GOES

Use-Case 9: Fire Weather Impacts to the Grid

- There are a lot of data integration issues here, because most infrastructure assets are in GIS databases, and many remotely sensed products are not initially compatible, requiring more work from the user
- Having high temporal resolution so there is a better understanding of where the fire is currently is critical
- Energy sector also tracks cloud dispersion and plumes which face the same constraints identified in earlier sessions
- A lot of current public safety power shutoffs are informed by "boots on the ground" information because that is most up-to-date

Tool(s) Identified: VIIRS, Google Earth, TechnoSylva, ArcGIS, GeoCollaborate

Use-Case 10: Impacts to Transportation Infrastructure

- Tracking smoke plumes is critical for implementing temporary flight restrictions; this needs to be identified earlier (higher resolution)
- Smart highway systems (sensors) will help inform this issue as well in the future timeframe
- For communities which are not road-based (e.g., Alaska), understanding these impacts can fundamentally change the nature of a fire response
- Hotspot detection could be integrated with some sort of automated alerting system, so responders have near-real time information about current risk areas
- There is a need to improve elimination of false detections on satellite data

Tool(s) Identified: GOES, Temporary Flight Restrictions

Use-Case 11: Wildland Urban Interface Factors

- Updated and timely information on land cover change (e.g., newly built-up areas) is a huge limitation in this space; if responders do not know that new construction is in an area, additional lives are placed at risk
- Some sort of predictive capability to understand evacuation windows would be useful as machine learning improves
- Vegetation indices also need to be kept up to date, since this influences fire behavior
- Archival data would also support a more effective response in these cases; incident commanders could more easily implement effective strategies from previous incidents/seasons

Tool(s) Identified: Predictive AI, GOES

Next Steps

- Fire Survey will go out to the community for more detailed feedback
- Results from the survey will be shared with the fire community
- GEOXO will map the Fire Workshop and survey findings to NOAA mission service areas
- NOAA will start addressing putting data into GIS friendly formats, starting with existing GOES-R products
- Feedback and next steps will be shared at the 2020 Community Meeting on NOAA Satellites to be held Sept 29- Oct 2, 2020.

Thank you for your support and contributions to NOAAs future missions!